Faculty of Engineering
Department of Civil Engineering

Maintenance of transportation networks
by Prof. Mahmoud Enieb

9-Sep-24

1

1

Accreditation

• The Accreditation Board for Engineering and Technology.

• With Accreditation, students, employers and the society we serve can be confident that a program meets the quality standards that produce graduates prepared to enter a global workforce.

9-Sep-24

2

2

Maintenance of transportation networks covers

	To familiarize students with the different types of flexible and rigid pavements distresses (1).
	To familiarize students with the different methods to characterize distresses causes (1).
	Learn how to collect data in terms of zone, branch, section and sample units (2).

9-Sep-24

3

3

Maintenance of transportation networks covers

- Learn how to calculate Pavement Condition Index (PCI) for flexible and rigid pavements (1, 2, 5) .

- Be able to understand the basic concepts of pavement Maintenance and Rehabilitation Methods M&R (5).

9-Sep-24

4

4

Maintenance of transportation networks

Relationship to program outcomes

ABET 1-7		Civil Engineering Student Outcomes
1	√	An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2	√	An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety and welfare, as well as global, cultural, social, environmental, and economic factors.
5	√	An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks and meet objectives.

9-Sep-24

5

5

Civil Engineering Student Outcomes 1 to 7

- 1 An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. √

- 2 An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety and welfare, as well as global, cultural, social, environmental, and economic factors. √

- 3 An ability to communicate effectively, with a range of audiences.

- 4 An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.

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6

6

Civil Engineering Student Outcomes
1 to 7

- 5 An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks and meet objectives. √

- 6 An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

- 7 An ability to acquire and apply new knowledge as need using appropriate learning strategies.

9-Sep-24

7

7

Maintenance of transportation networks

8

Prerequisite

- Highway and airports Engineering

9-Sep-24 9

9

Instructor:
Prof. Dr. Mahmoud Enieb
Prof. of Highway Engineering

Instructor's Office 101

m.enieb@aun.edu.eg

10

Office hours

12:00 AM – 14:00 AM,
(Sun)

11

Classroom
Section 1 (Classroom 2)
(Thu, 11:00-13:00)

12

Course Description

- This course covers types of distresses in both flexible and rigid pavements and the causes for each type. Also it covers the principles of pavements maintenance and rehabilitation.
- Moreover, it covers the method for calculating pavement condition index (PCI) by using charts.

9-Sep-24

13

13

Textbooks

- 1.   Shahin,M.Y , "Pavements Managements for Airports ,Roads, and Parking Lots".2nd Ed. 2004.
- 2.   Technical   Manual   "TM5-623",   "Pavement   Maintenance Management"   by the Headquarters Department Of The Army ,Washington, DC, November 1982.

9-Sep-24

14

14

Course objectives

- To familiarize students with the different types of flexible and rigid pavements distresses. (1)

- To familiarize students with the different methods to characterize distresses causes. (1)

- Learn how to collect data in terms of zone, branch, section and sample units. (2)

9-Sep-24   15

15

Course objectives

- Learn how to calculate pavement condition index (PCI) for rigid and flexible pavements. (1, 2,5)

- Be able to understand the basic concepts of pavement Maintenance and Rehabilitation Methods M&R. (5)

9-Sep-24   16

16

Topics Covered

- Distresses in flexible pavement.
- Distresses in rigid pavement.
- PCI of flexible pavements.
- PCI of rigid pavement.
- Pavement maintenance and rehabilitation methods M&R

9-Sep-24

17

17

Class Schedule

- 1 class session each week; 75 minutes.
    - (Thu, (11:00-13:00)

Grading Plan:

- Assignments & Project (10), Attends and participation (10).
- Mid Exam   (10 Marks)
- Final Exam   (70 Marks)
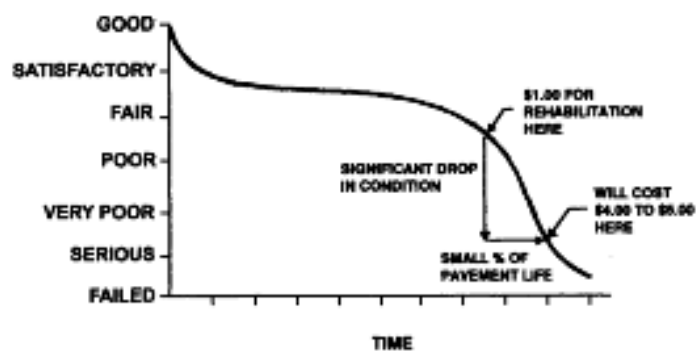
9-Sep-24

18

18

General notes

- All cellular phone must be turned off before class begins.
- Eating and/or drinking is not allowed in the classroom.
- Talking to a fellow student while the lecture is in progress will not be tolerated.
- You will be asked to leave the class if this behavior is disruptive.
- As required by the university, cases of academic dishonesty will be handled through the proper channels.

9-Sep-24   19

19

Introduction , pavement condition

- Conceptual illustration of a pavement condition life cycle

9-Sep-24   20

20

Distresses

21

Elements of pavement evaluation:

- Type of distress.
- Severity level: (L : low), (M : medium) and (H :high).
- Density / Extent.
- Unit of measure

9-Sep-24   22

22

Two types of pavement failure :

- **Structural failure** is associated with the ability of the pavement to carry the design load, whereas

- **functional failure** is associated with ride quality and safety. When structural failure increases in severity, it always results in functional failure as well.

9-Sep-24 23

23

Distresses Causes

1. Design
2. Construction
3. Poor materials.
4. Load
5. Climate

9-Sep-24 24

24

Distresses in Flexible Pavements

9-Sep-24

25

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1 - Cracking

• Alligator Cracking.

• Block Cracking

• Edge Cracking.

• Longitudinal and Transverse Cracking.

• Slippage Cracking

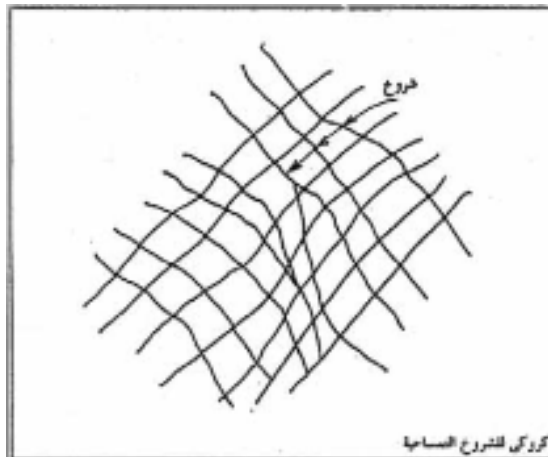9-Sep-24

26

26

A. Alligator Cracking

- It is a series of interconnecting cracks caused by fatigue failure of the asphalt concrete surface under repeated traffic loading.

- The cracks propagate to the surface initially as a series of parallel longitudinal cracks. After repeated traffic loading, the cracks connect, develop a pattern resembling the skin of an alligator.

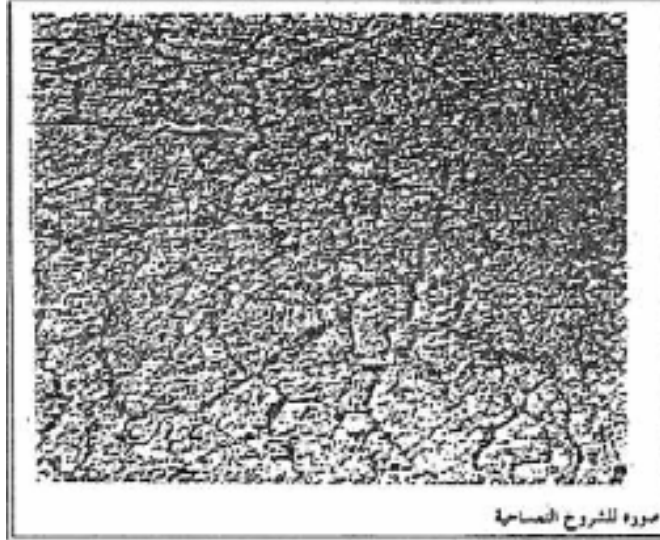9-Sep-24   27

27

Sketch Alligator Cracking

كروكى للشروخ التمساحية

9-Sep-24   28

28

Picture Alligator Cracking

صورة للشروخ التمساحية

9-Sep-24   29

29

Severity alligator cracking

درجة الشدة :

- قليلة الشدة " L " حيث تكون الشروخ شعرية وموازية لبعضها البعض ولا تتقاطع وعرض الشرخ لا يزيد عن ١سم .

- متوسط الشدة" M " حيث تكون الشروخ بسيطة متقاطعة مكونة قطع صغيرة وعرض الشرخ يتراوح من ١سم وحتى ٥ر٢سم .

- عالية الشدة " H "   حيث تكون الشروخ كبيرة ومتقاطعة لبعضها البعض مكونة تقسيمات ظاهرة وعرض الشرخ أكبر من ٥ر٢سم.

9-Sep-24   30

30

low-severity alligator cracking:

• longitudinal cracks running parallel to each other with no, or only an interconnecting cracks.

9-Sep-24   31

31

• **Medium-severity alligator cracking :**

pattern or network of cracks.

9-Sep-24   32

32

- **high-severity alligator cracking:**

  Network or pattern cracking has progressed so that the pieces are well defined (pavement surface looks like separate particles).

9-Sep-24

33

33

How to Measure:
Alligator cracking is measured in **square feet or meter** of surface area.

- The major difficulty in measuring this type of distress is that two or three levels of severity often exist within one distressed area. If these portions can be easily distinguished from each other, they should be measured and recorded separately. **However, if the different levels of severity cannot be divided easily, the entire area should be rated at the highest severity present.**

9-Sep-24

34

34

Example

During asphalt pavement inspection of link (100*10 or 5) M, from desert road in Egypt during, 20 m² high, 30 m² low, alligator cracking distress type. Determine total deduct value for this distress.

61 78

78 61

30 30

$20/(100*10)*100 = 2\%$ H
$30/(100*10)*100 = 3\%$ L

$20/(100*5)*100 = 4\%$ H
$30/(100*5)*100 = 6\%$ L

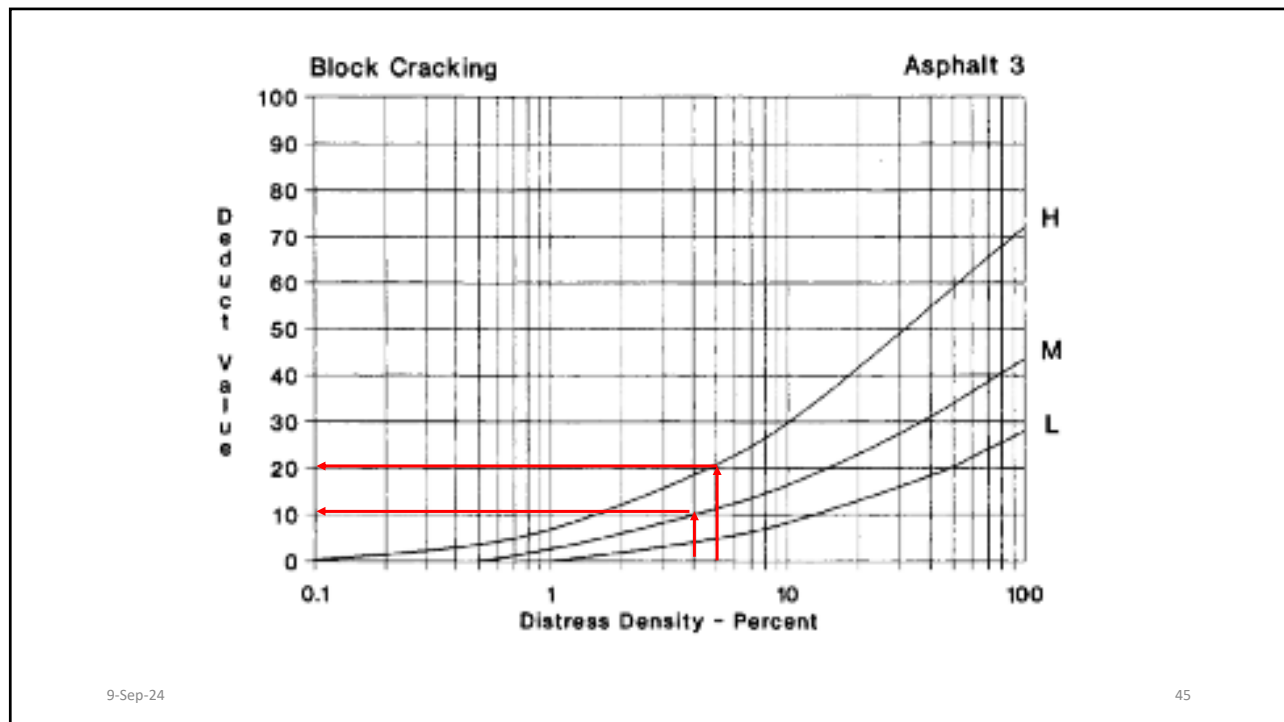9-Sep-24   35

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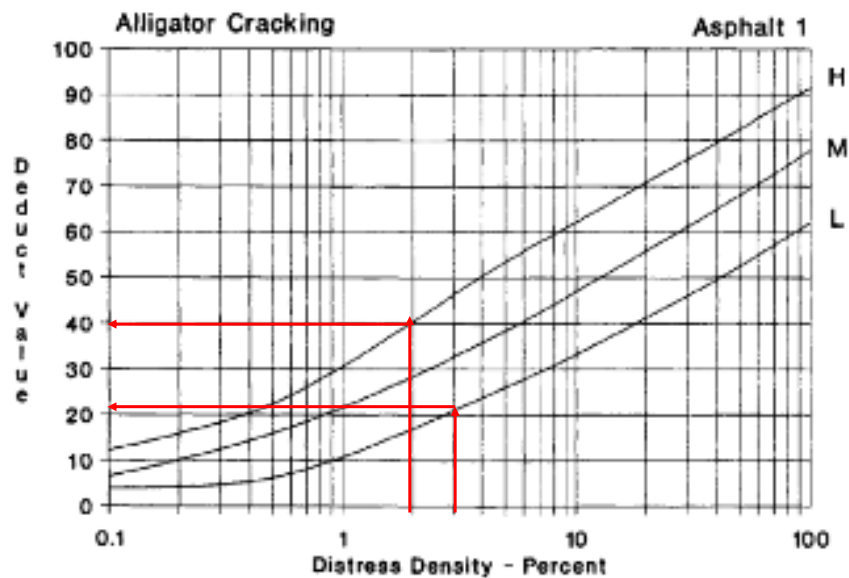
9-Sep-24   36

36

B -Block Cracking.

- Block cracks are interconnected cracks that divide the pavement into approximately rectangular pieces. The blocks may range in size from approximately (30 cm by 30 cm) to (3 by 3 m).

- Block cracking is caused mainly by shrinkage of the asphalt concrete and daily temperature cycling (which results in daily stress/strain cycling). **It is not load-associated**

9-Sep-24   37

37

Sketch block Cracking

Medium – Adjacent Low Severity Cracking
High – Adjacent Medium Severity Cracking
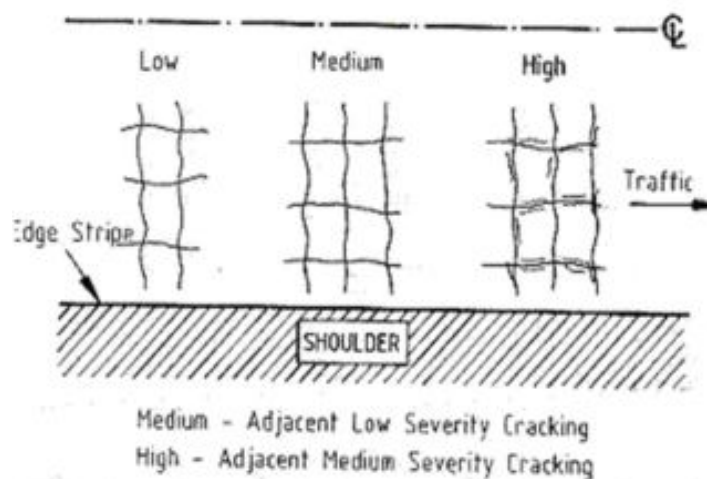
9-Sep-24   38

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- Low-severity

9-Sep-24   39

39

- **High-severity block cracking**

9-Sep-24   40

40

Severity block Cracking

درجة الشدة :

– قليلة الشدة " L "   فى حالة الشروخ ذات عرض أقل من واحد سم .

– متوسطة الشدة " M " فى حالة الشروخ ذات عرض من واحد سم الى ٢سم .

– عالية الشدة " H "   فى حالة الشروخ ذات عرض أكبر من ٢سم .

41

What are the difference between alligator and block cracking?

• **This type of distress differs from alligator cracking** in that alligator cracks form smaller, many-sided pieces with sharp angles.

• Also, unlike block, alligator cracks are caused by repeated traffic loadings, and are therefore found only in traffic areas (i.e., wheel paths).

42

How to Measure:
Block cracking is measured in **square feet or meter** of surface area.

43

Example

During asphalt pavement inspection of link (100*10 or 5) M, from road in Egypt during, (5x8) 40 m² (4%, 8% density) medium, 50 m² high, block cracking distress type. Determine deduct value for this (high) distress.
10 45
21 15
30 30

44

Block Cracking   **Asphalt 3**

9-Sep-24   45

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C. Edge Cracking

• Edge cracks are parallel to and usually within 1 to 2 ft (0.3 to 0.6 m) of the outer edge of the pavement.

في اماكن اتصال الاسفلت القديم بالحديث عند عمل توسعات بالطريق
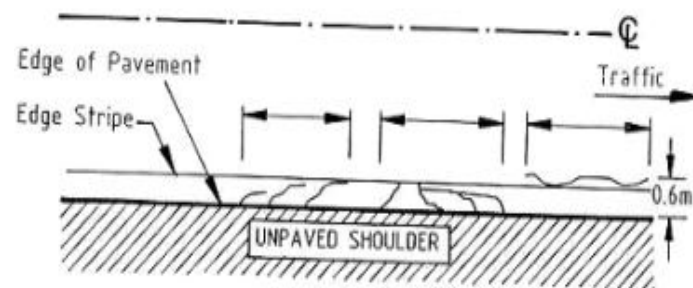
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46

Sketch Edge Cracking
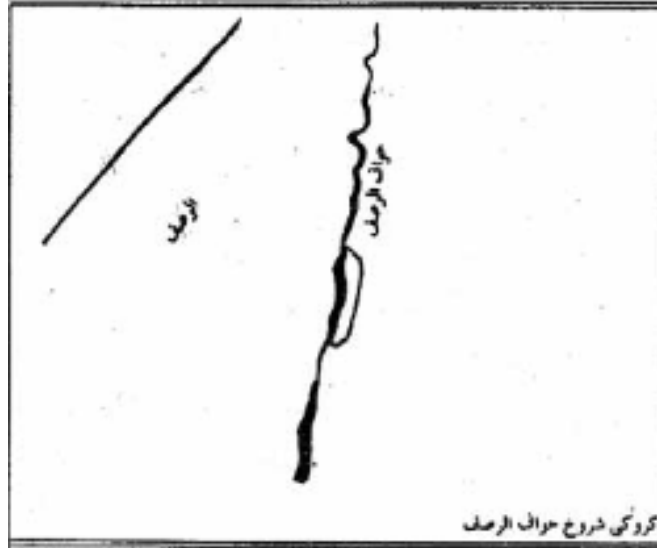
47

Severity Edge Cracking

درجَة الشدة :

– قليلة الشدة " L " شـروخ طوليـة بسـيطة بـدون إنفصـال للمـواد أو تكسـير بعرض لا يزيد عن ١سم .

– متوسطة الشدة " M " شروخ طولية متوسطة مع تكسير وإنفصال للمواد فـى بعض المناطق وعرض الشرخ يتراوح ما بين ١سم وحتى ٣و ١سم .

– عالية الشدة " H " شروخ طولية عالية الشدة مع تكسير وإنفصال المواد على طول حرف الرصف وعرض الشرخ يزيد عن ٣و ١سم .

48

Prepared by Prof. Mahmoud Enieb   24

- This distress is accelerated by traffic loading and can be caused by **frost weakened base or subgrade near the edge of the pavement.**

- The area between the crack and pavement edge is classified as raveled متصدعة if it is broken up (sometimes to the extent that pieces are removed)

9-Sep-24

49

49

Low-severity edge cracking: no breakup or raveling.

9-Sep-24

50

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How to Measure: Edge cracking is measure in linear feet or meter.

51

Example

During asphalt pavement inspection of link (100*7.5, 15) M, from road in Egypt during, 40 m low, 50 m high, Edge cracking distress type. Determine deduct value for this (high) distress.

4   14

18   22

22   18

52

Edge Cracking (Metric Units) — Asphalt 7
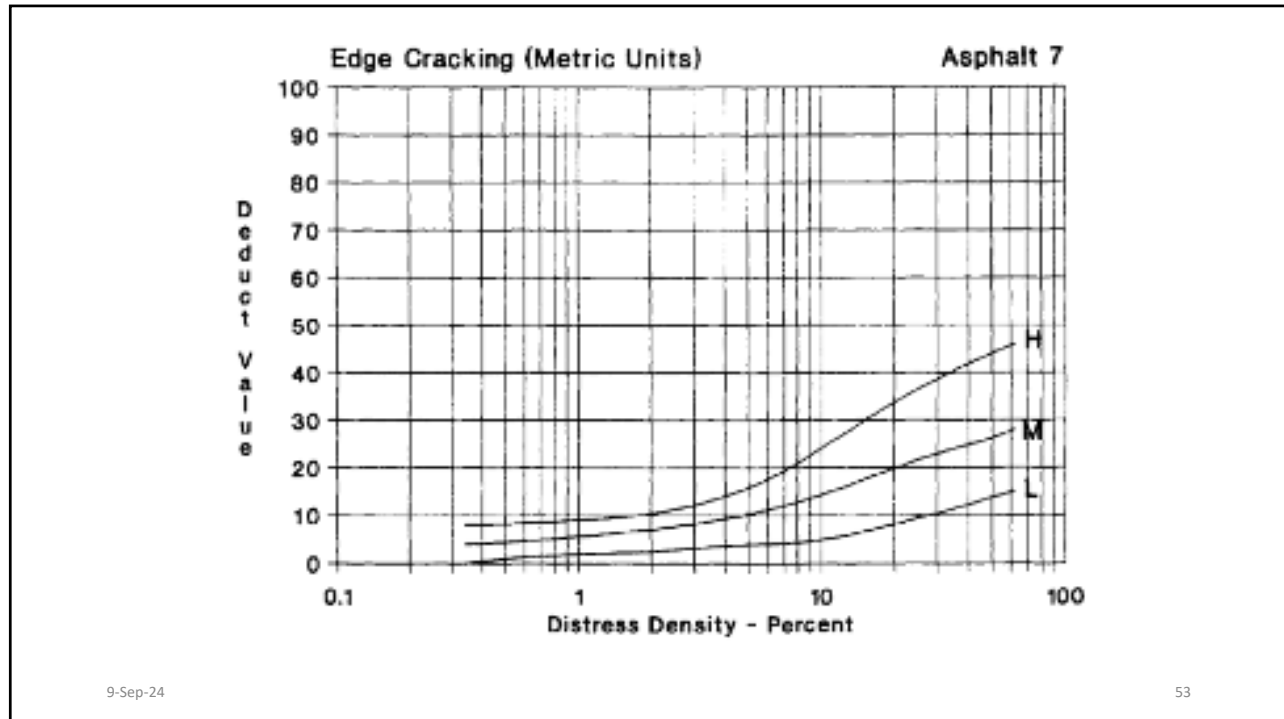
53

D -Longitudinal and Transverse Cracking

- Longitudinal cracks are parallel to the pavement's centerline while Transverse cracks extend across the pavement at approximately right angles to the pavement centerline .

54

They may be caused by:

- Shrinkage of the AC surface due to low temperatures or by daily temperature cycling.

- Hardening of the asphalts.

- Cracking reflection

- Loss of stability

9-Sep-24   55

55

Sketch Longitudinal and Transverse Cracking

كروكي الشروخ الطولية والعرضية
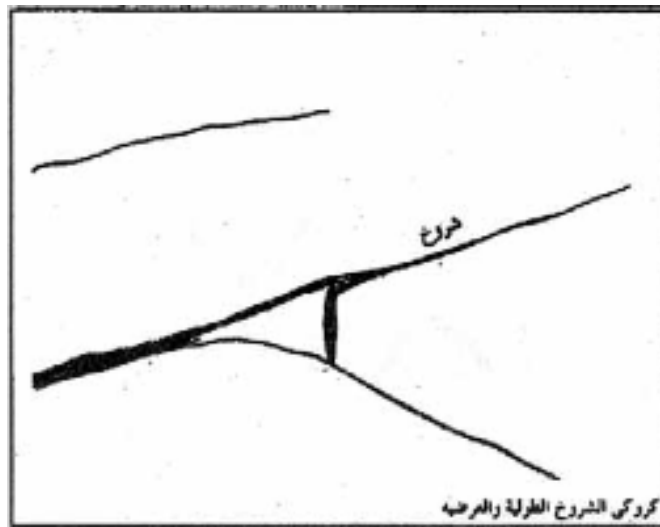
9-Sep-24   56

56

Severity Longitudinal and Transverse Cracking

درجة الشدة :

– قَليلة الشدة " L " عرض الشروخ أقل من واحد سنتيمتر .

– متَوسطة الشدة   " M " عرض الشروخ من ١ سم حتى ٥ر٢ سم

– عالية الشدة   " H " عرض الشروخ أكبر من ٥ر٢ سم .

Field Longitudinal and transverse cracks

How to measure :Longitudinal and transverse cracks are measured in linear feet or meter.

Options for Repair
L—Do nothing; Seal cracks > 1/8 in. wide.
M—Seal cracks.
H—Seal cracks; Partial-depth patch.

Example

During asphalt pavement inspection of link (100*7.5, 10) M, from road in Egypt during, 60 m high, 40 m medium, Longitudinal and transverse cracking distress type. Determine deduct value for this (medium) distress.

55   24
49   20
104 44
79   70

Longitudinal/Transverse Cracking — Asphalt 10
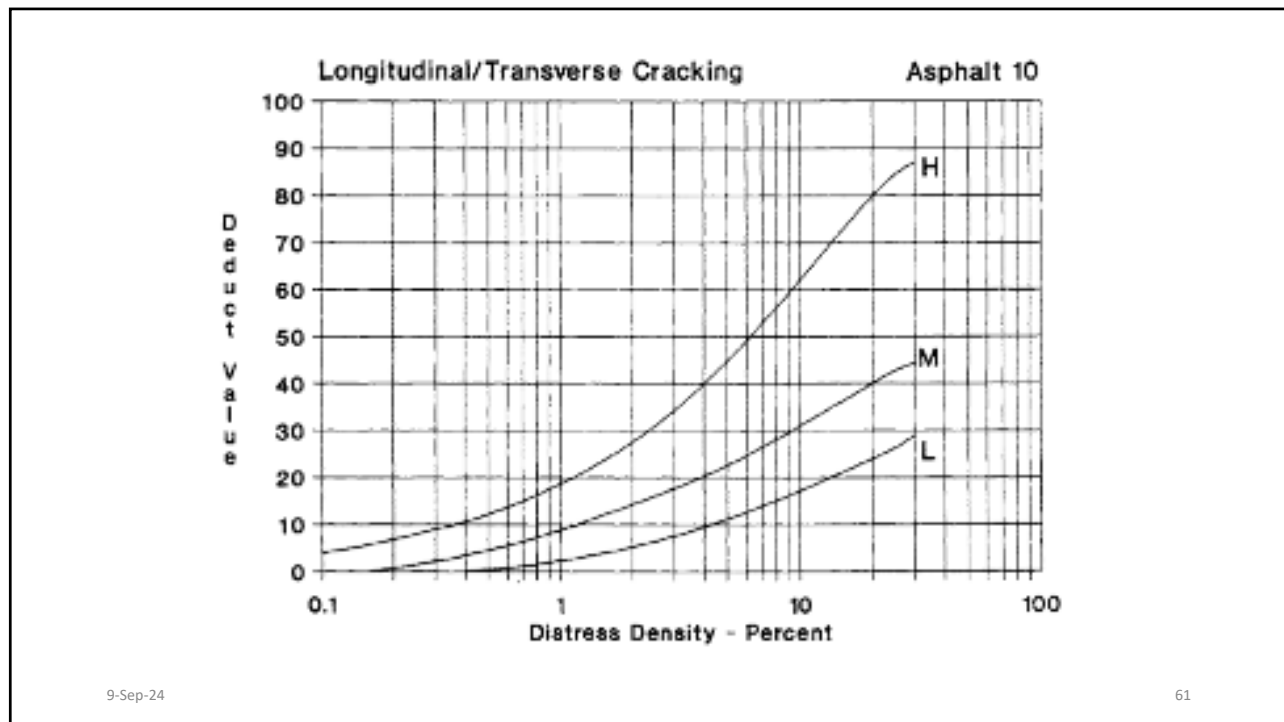
61

E. Slippage Cracking

• Slippage cracks are crescent or half-moon shaped cracks.

• They are produced when braking or turning wheels cause the pavement surface to slide or deform.

• This distress usually occurs when there is a low strength surface mix

• or poor bond between the surface and the next layer of the pavement structure.

62

Sketch Slippage Cracking
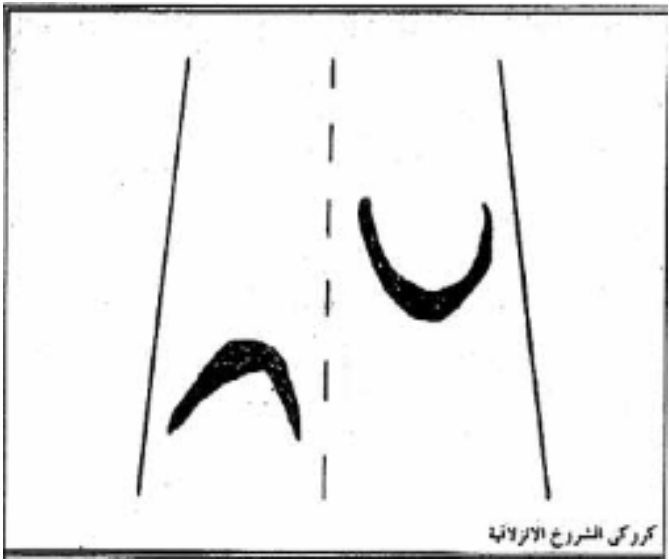
9-Sep-24

63

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Field Slippage Cracking

9-Sep-24

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Severity Level

- L—Average crack width is < 3/8 in. (10 mm).
- M—One of the following conditions exists:
-     1. Average crack width between 3/8 in. and 1-1/2 in. (10 mm and 38 mm).
-     2. The area around the crack is broken into tight-fitting pieces.
- H—One of the following conditions exists:
-     1. The average crack width is greater than 1-1/2 in. (38mm).
-     2. The area around the crack is broken into easily removed pieces.

9-Sep-24   65

65

How to Measure Slippage Cracking

- The area associated with a given slippage crack is measured in **square feet or meter** and rated according to the highest level of severity in the area.
- **Options for Repair**
- L—Do nothing; Partial-depth patch.
- M—Partial-depth patch.
- H—Partial depth patch

9-Sep-24   66

66

Example

During asphalt pavement inspection of link (100*10 or 5) M, from road in Egypt during, (8x10) 80 m² low, 100 m² high, Slippage Cracking distress type. Determine deduct value for this (high) distress.

24 91
67 78
91 32
110 24
78 110

9-Sep-24   67

67

Slippage Cracking   Asphalt 17
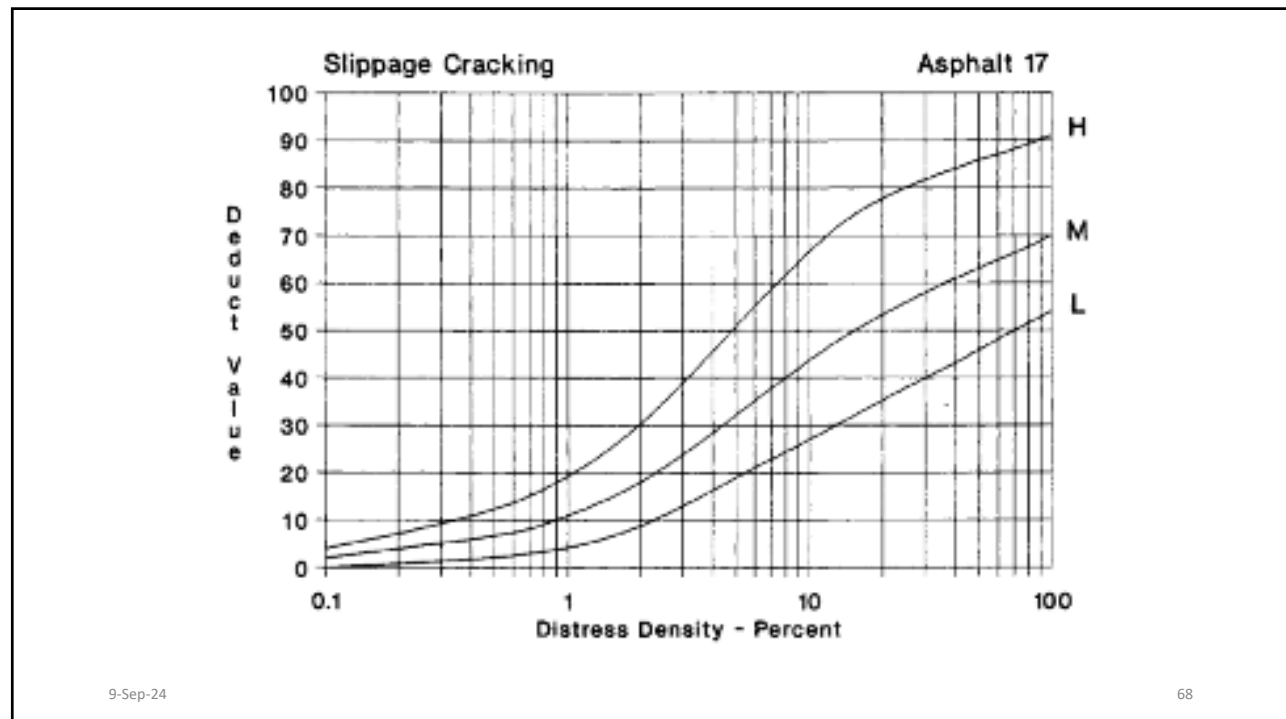
9-Sep-24   68

68

2 – Surface Distortion
عيوب ناشئة عن تشوه استواء السطح

- Corrugations.
- Depression
- Shoving.
- Rutting.
- Swelling or upheaval.
- Sag and Bumps.
- Lane / shoulder Drop off

9-Sep-24   69

69

A. Corrugations

- Corrugation is a series of closely spaced ridges and valleys (ripples) occurring at fairly regular intervals, usually < 10 ft (3 m) along the pavement.
- The ridges are perpendicular to the traffic direction.
- This type of distress is usually caused by traffic action combined with an unstable pavement surface or base.
- If bumps occur in a series of < 10 ft (3 m), due to any cause, the distress is considered corrugation.

9-Sep-24   70

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Corrugations Sketch
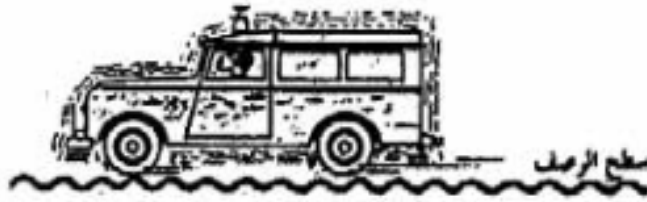
9-Sep-24   71

71

Corrugations Severity Levels

L—Corrugation produces low severity ride quality.

M—Corrugation produces medium-severity ride quality جودة السفر.

H—Corrugation produces high-severity ride quality

9-Sep-24   72

72

Corrugations

How to Measure

Corrugation is measured in **square meters (feet)** of surface area.

Options for Repair

L—Do nothing.

M—Reconstruction.

H—Reconstruction.

9-Sep-24 73

73

Example

During asphalt pavement inspection of link (100*7) M, from road in Egypt, 49 m^2 low, 63 m^2 high, corrugation distress type. Determine deduct value for this distress.

10

60

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9-Sep-24 74

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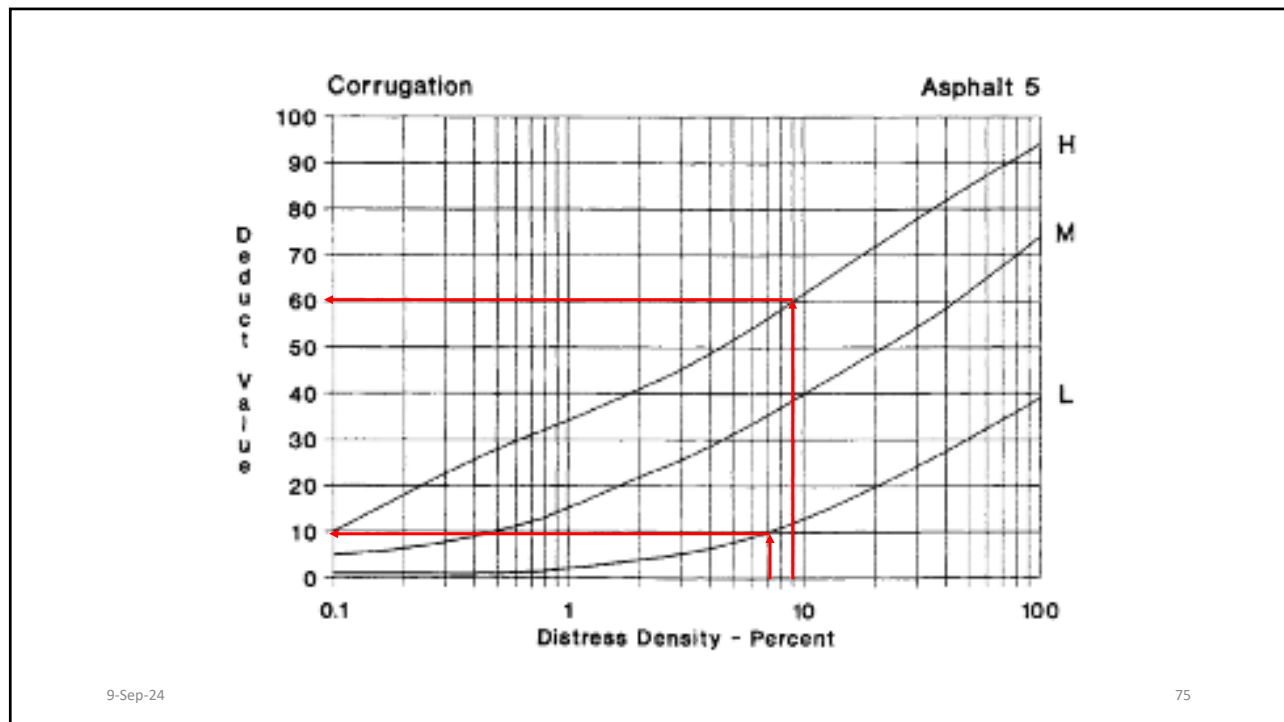
75

B. Depression

- Depressions are localized pavement surface areas with elevations slightly lower than those of the surrounding pavement.

- In many instances, light depressions are not noticeable until after a rain, when ponding water creates a "birdbath" area; on dry pavement, depressions can be spotted by looking for stains caused by ponding water.

- Depressions are created by settlement of the foundation soil or are a result of improper construction.

- Depressions cause some roughness, and when deep enough or filled with water, can cause hydroplaning

9-Sep-24   76

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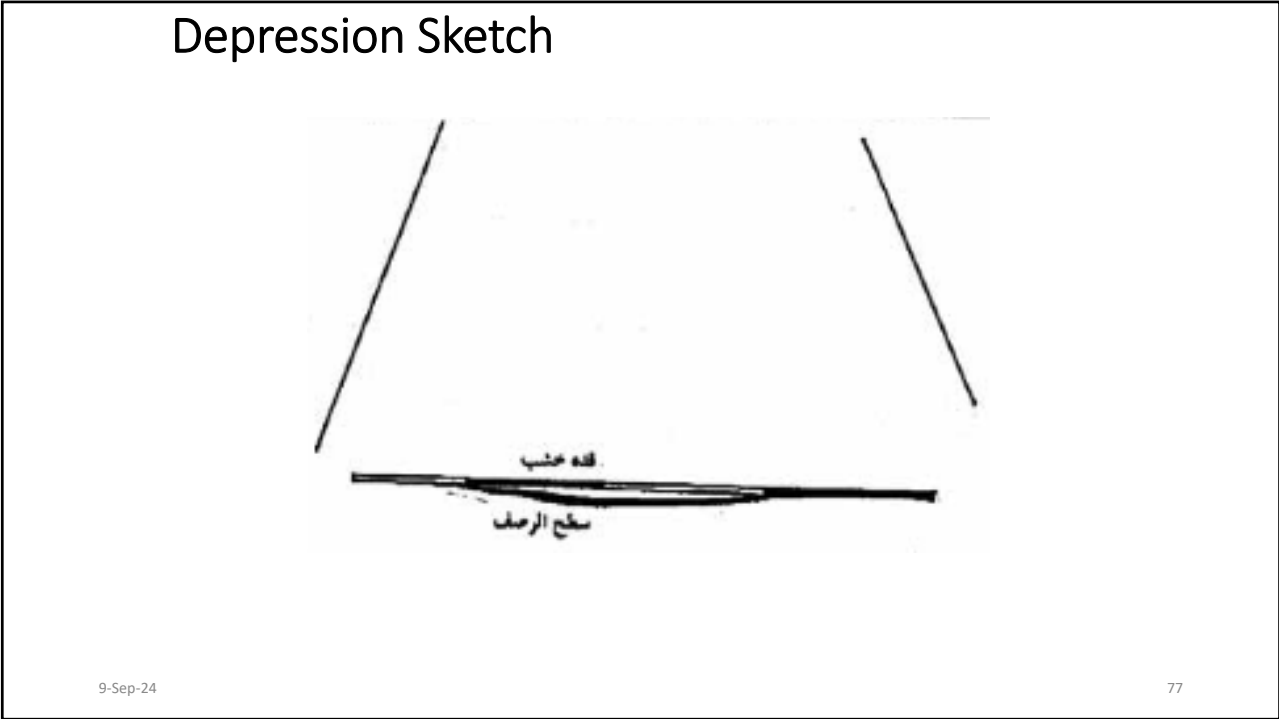
Depression Sketch

77
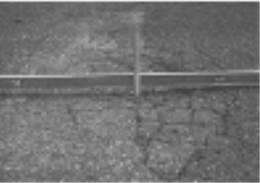
Depression Severity Levels

Maximum Depth of Depression

L—13 to 25 mm (1/2 to 1 in.).

M—25 to 50 mm (1 to 2 in.)

H—more than 50 mm (2 in.)

78

Depression

How to Measure

Depressions is measured in **square meters (feet)** of surface area.

Options for Repair

L—Do nothing.

M—Shallow, partial, or full-depth patch.

H—Shallow, partial, or full-depth patch.

9-Sep-24

79

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Example

During asphalt pavement inspection of link (100*7) M, from road in Egypt, 280 m^2 low, 42 m^2 medium, depression distress type. Determine deduct value for low distress.

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9-Sep-24

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9-Sep-24

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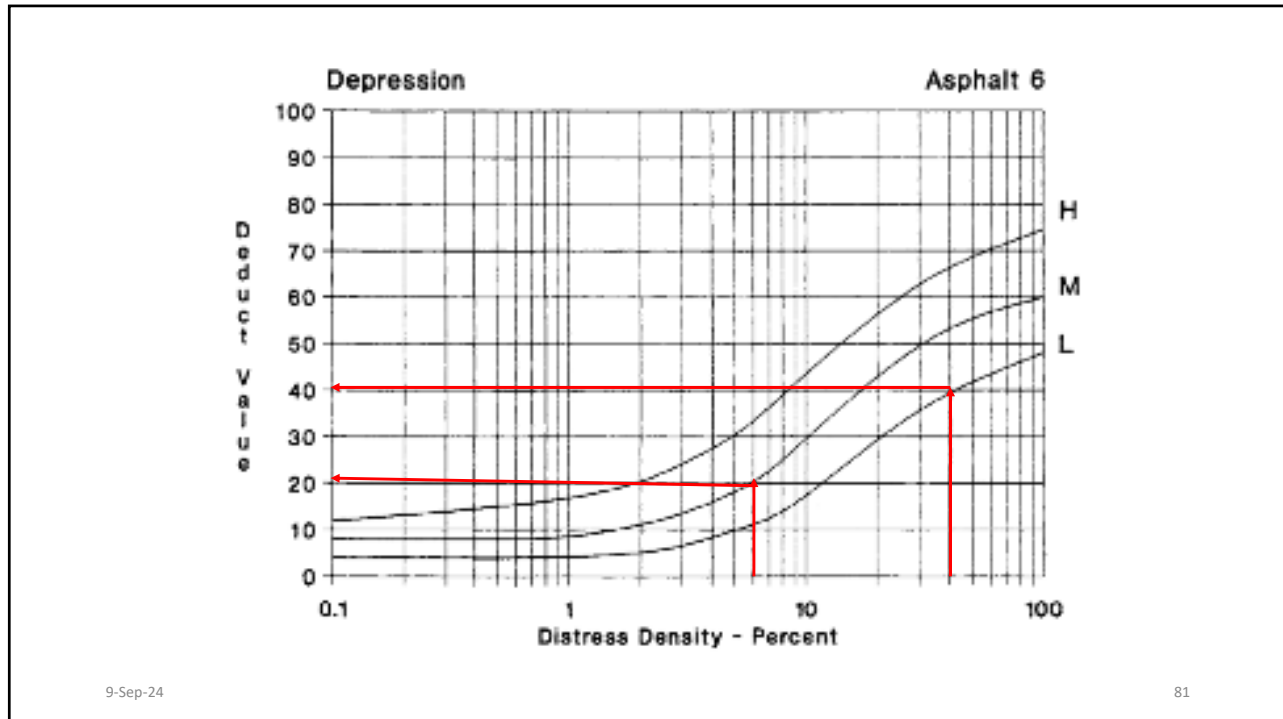
81

C. Shoving

- Shoving is a permanent, longitudinal displacement of a localized area of the pavement surface caused by traffic loading. When traffic pushes against the pavement, it produces a short, abrupt wave موجة مفاجئة in the pavement surface. This distress normally occurs only in unstable liquid asphalt mix (cutback or emulsion) pavements..

- Shoves also occur where asphalt pavements abut PCC pavements; the PCC pavements increase in length and push the asphalt pavement, causing the shoving.

9-Sep-24   82

82

Shoving Sketch

كروكى تكوم الرصف فى الاتجاه العرضى

9-Sep-24

83

83

Shoving Severity Levels

L—Shove causes low severity ride quality.

M—Shove causes medium severity ride quality.

H—Shove causes high-severity ride quality.

LOW

MEDIUM

HIGH

9-Sep-24

84

84

Shoving

How to Measure

Shoves are measured in **square meter (feet)** of surface area. Shoves occurring in patches are considered in rating the patch, not as a separate distress.

Options for Repair

L—Do nothing; Mill.

M—Mill; Partial or full-depth patch.

H—Mill; Partial or full-depth patch.

9-Sep-24

85

85

Example

During asphalt pavement inspection of link (100*7) M, from road in Egypt, 21 m² low, 42 m² medium, shoving distress type. Determine deduct value for low distress.

10

28

38

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9-Sep-24

86

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Shoving

Asphalt 16

9-Sep-24

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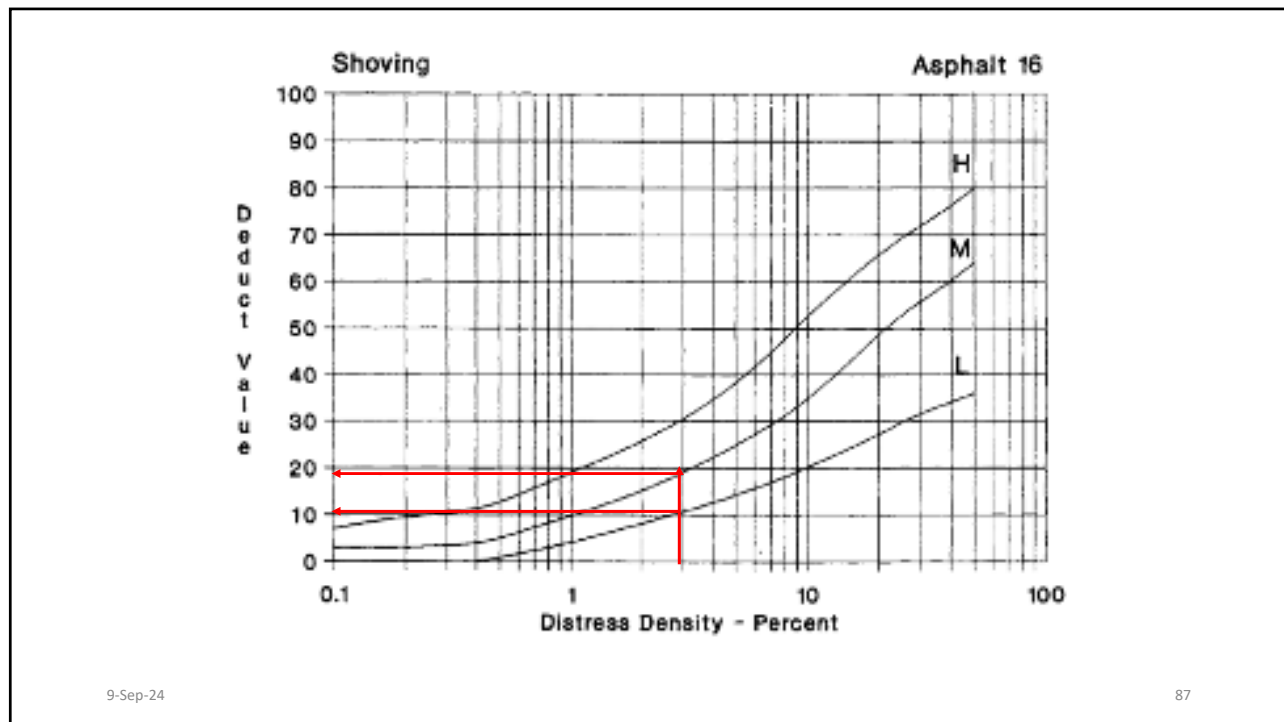
87

D. Rutting

- A rut is a surface depression in the wheel path. Pavement uplift may occur along the sides of the rut; however, in many instances ruts are noticeable only after a rainfall, when the wheel paths are filled with water. Rutting stems from a permanent deformation in any of the pavement layers or subgrade.

- It is usually caused by consolidation or lateral movement of the materials due to traffic loads.

- Significant rutting can lead to major structural failure of the pavement.

9-Sep-24

88

88

Rutting Sketch
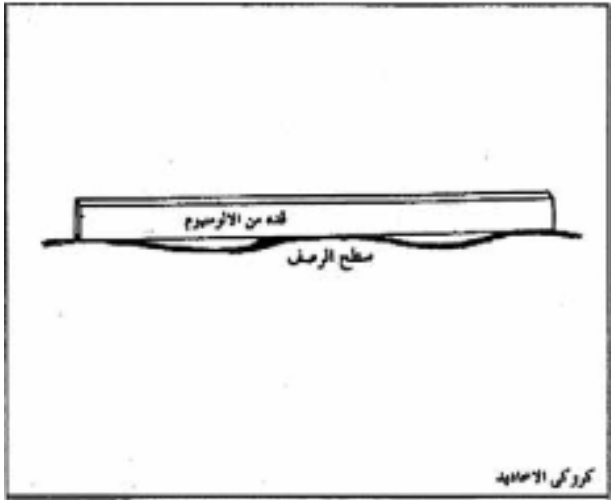
9-Sep-24 89

89

Rutting Severity Levels

L—Less than 1/4 to 1/2 in. (<6.4 to 12.7 mm).
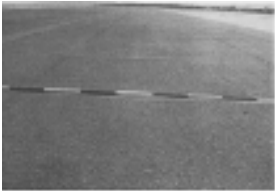
M— From 1/2 to 1 in. (12.7 to 25.4 mm).
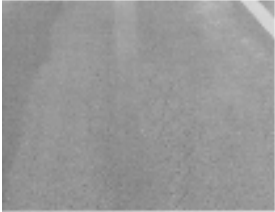
H—Greater than 1 in. (25.4 mm.

9-Sep-24 90

90

Rutting

How to Measure

Rutting is measured in **square feet (square meters)** of surface area, and its severity is determined by the depth of the rut. To determine the rut depth, a straightedge should be laid across the rut and the maximum depth measured.
The mean depth in inches (mm) should be computed from measurements taken along the length of the rut.

Options for Repair

L—Do nothing.
M—Shallow, partial or full-depth patch; Partial or full-depth patch and overlay.
H—Shallow, partial or full-depth patch; Partial or full-depth patch and overlay.

9-Sep-24   91

91

Example

During asphalt pavement inspection of link (100*14) M, from desert road in Egypt, 56 m^2 low, 112 m^2 high, rutting distress type. Determine deduct value for distress.
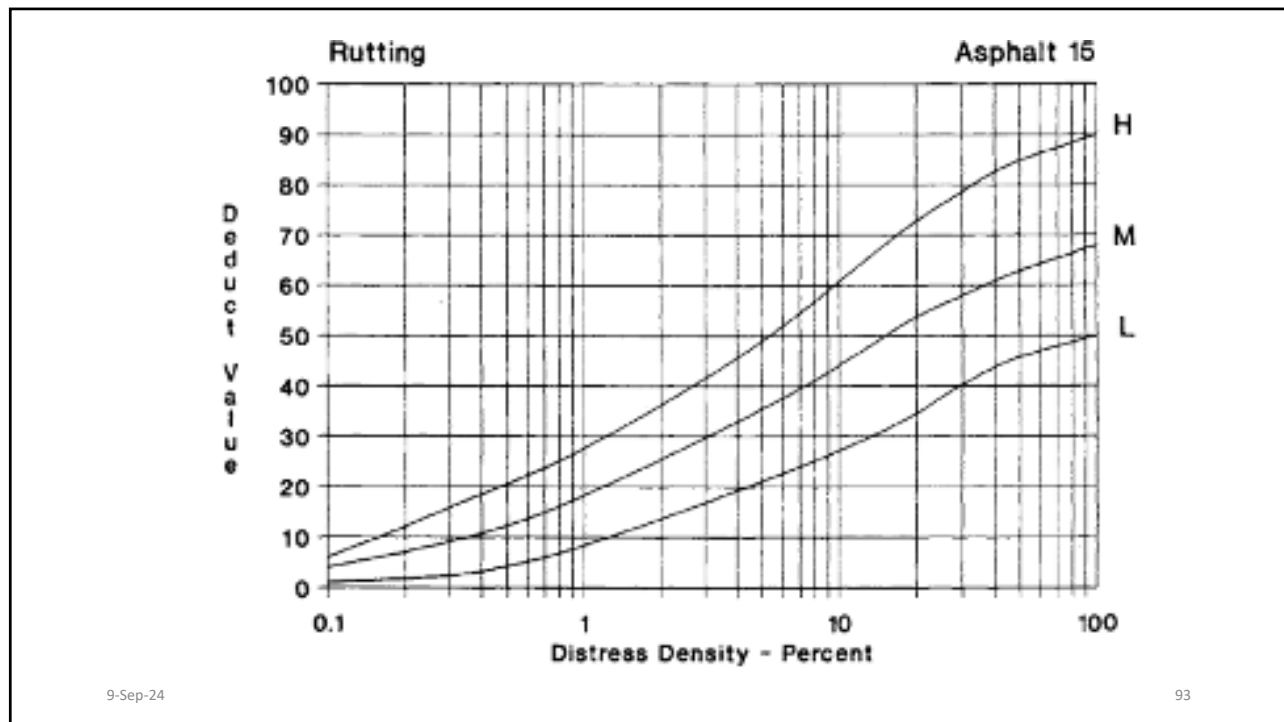19

58

77

9-Sep-24   92

92

Rutting — Asphalt 15

93

E. Swelling or upheaval

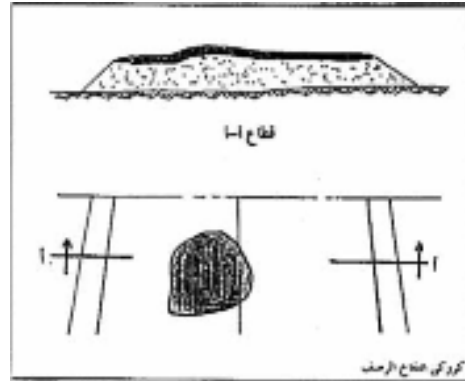- Swell is characterized by an upward bulge in the pavement's surface—a long, gradual wave greater than 10 ft (3 m) long. Swelling can be accompanied by surface cracking.

- This distress is usually caused by frost action in the subgrade or by swelling soil.

9-Sep-24   94

94

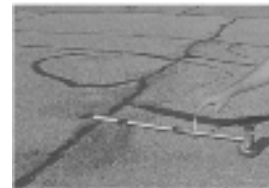# Swelling Sketch

9-Sep-24   95

95

Swelling Severity Levels

L—Swell causes low-severity ride quality. Low-severity swells are not always easy to see but can be detected by driving at the speed limit over the pavement section. An upward motion will occur at the swell if it is present.

M—Swell causes medium severity ride quality.

H—Swell causes high severity ride quality.

9-Sep-24   96

96

swelling

How to Measure

The surface area of the swell is measured in **square feet (square meters)**.

Options for Repair

L—Do nothing.
M—Do nothing; Reconstruction.
H—Reconstruction.

9-Sep-24

97

97

Example

During asphalt pavement inspection of link (100*14) M, from road in Egypt, 42 m² high, 70 m² medium, swelling distress type. Determine deduct value for medium distress.
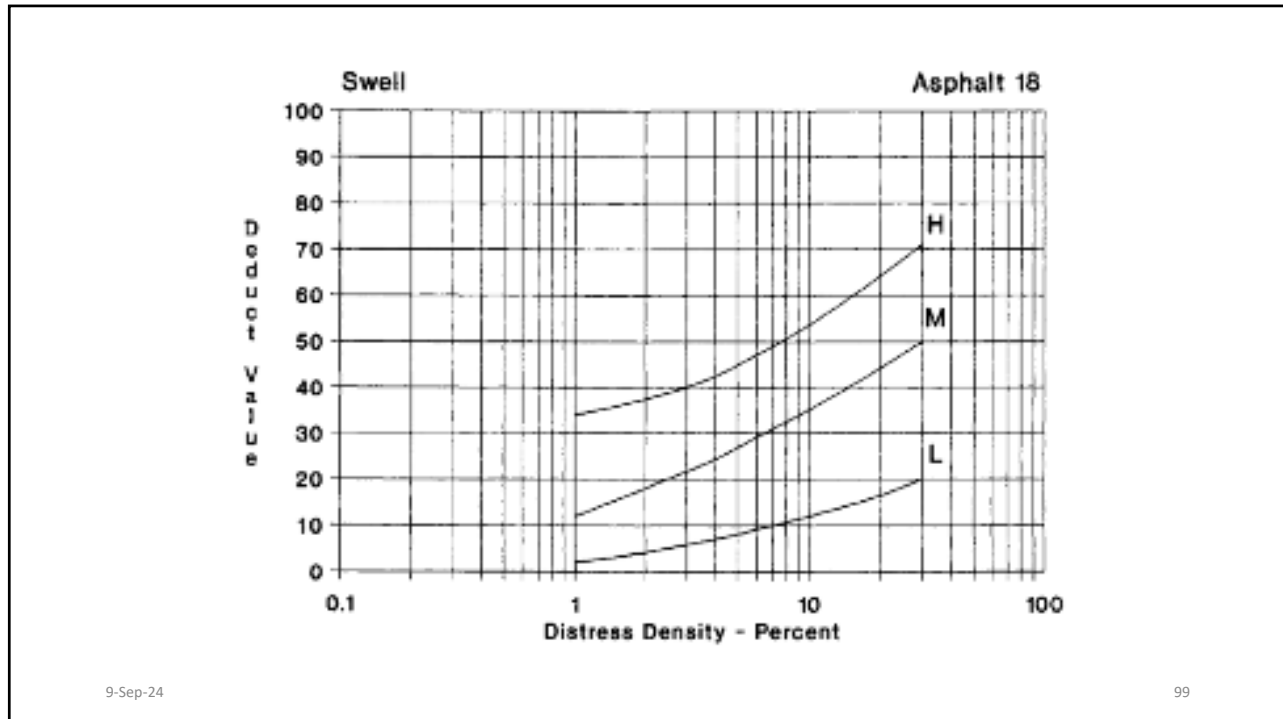
40

27

67

9-Sep-24

98

98

99

F. Sag and Bumps

- Bumps are small, localized, upward displacements of the pavement surface. They are different from shoves in that shoves are caused by unstable pavement. Bumps, on the other hand, can be caused by several factors, including:

- 1. Buckling or bulging of underlying PCC slabs in AC overlay over PCC pavement.

- 2. Frost heave (ice, lens growth).

- 3. Infiltration and buildup of material in a crack in combination with traffic loading (sometimes called "tenting خيمة").
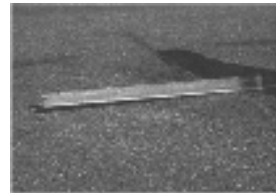
100

Sag and Bumps Sketch
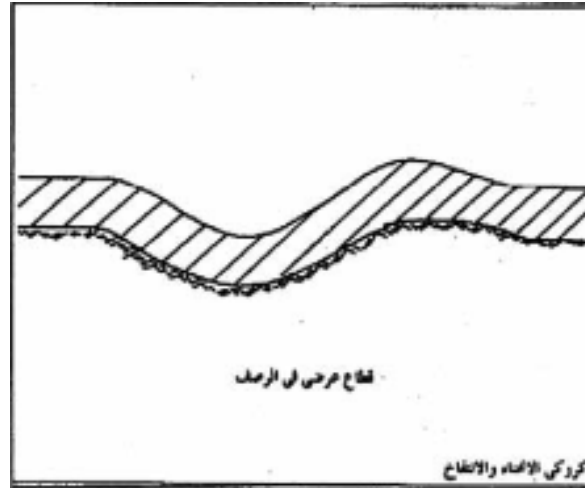
9-Sep-24

101

101

Sag and Bumps Severity Levels

L—Bump or sag causes low severity ride quality.

M—Bump or sag causes medium severity ride quality.

H—Bump or sag causes high severity ride quality.

9-Sep-24

102

102

Sag and Bumps

How to Measure

Bumps or sags are measured in **linear feet or meter**. If bumps appear in a pattern perpendicular to traffic flow and are spaced at <10 ft (3 m), the distress is called corrugation. If the bump occurs in combination with a crack, the crack is also recorded.

Options for Repair

L—Do nothing.
M—Cold mill; Shallow, partial or full-length patch.
H—Cold mill; Shallow, partial or full-depth patch; Overlay.

9-Sep-24

103

103

Example

During asphalt pavement inspection of link (100*20) M, from road in Egypt, 100 m low, 100 m high, Sag and bump distress type. Determine deduct value for this (High) distress.
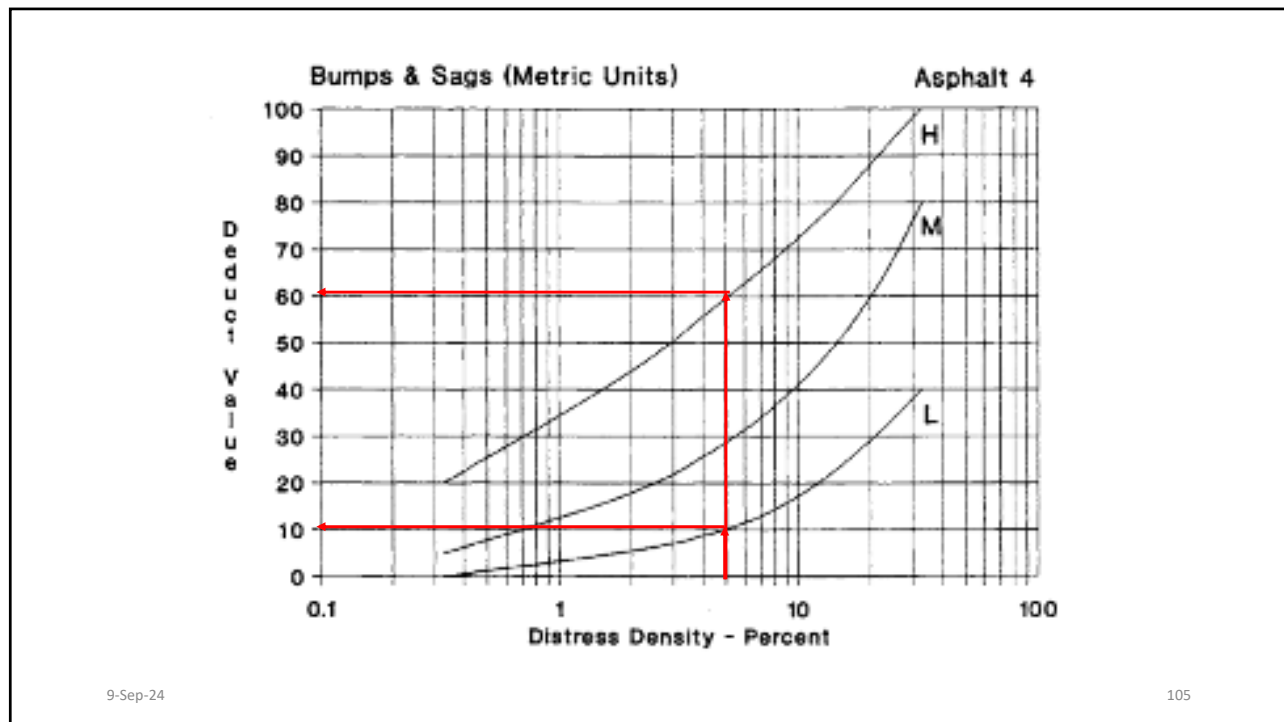
10 10

60 60

70 70

9-Sep-24

104

104

Bumps & Sags (Metric Units) — Asphalt 4
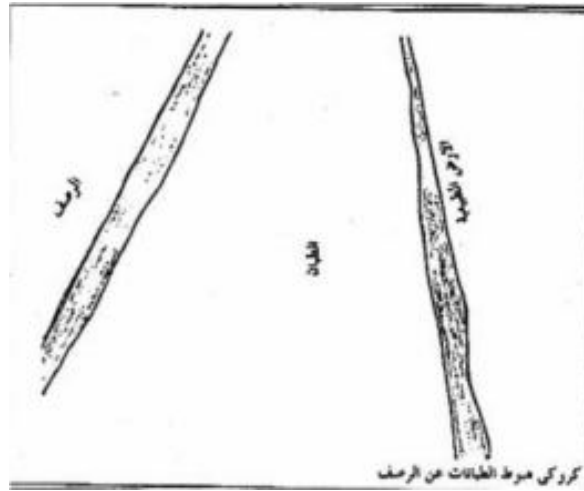
9-Sep-24

105

105

K. Lane / shoulder Drop off

- Lane/shoulder drop-off is the difference between the settlement or erosion of the shoulder and the pavement travel-lane edge.
- The elevation difference can be a safety hazard; it can also cause increased water infiltration.

9-Sep-24

106

106

Lane / shoulder Drop off Sketch

9-Sep-24 107

107

Lane / shoulder Drop off Severity Levels

L—The difference between the pavement edge and shoulder is 1 to 2 in. (25 to 51 mm).

M—The difference in elevation is 2 to 4 in. (51 to 102 mm).

H—The difference in elevation is >4 in. (102 mm

9-Sep-24 108

108

Lane / shoulder Drop off

How to Measure
Feet or meter length.
The mean lane/shoulder drop off is computed by averaging the maximum and minimum drop along the slab. Each slab exhibiting distress is measured separately and counted as one slab with the appropriate severity level.

Options for Repair

L, M, H—Regrade and fill shoulders to match lane height.

9-Sep-24   109

109

Example

During asphalt pavement inspection of link (100*10) M, from road in Egypt, 40 m medium, 300 m high, lane / shoulder drop off distress type. Determine deduct value for high distress.
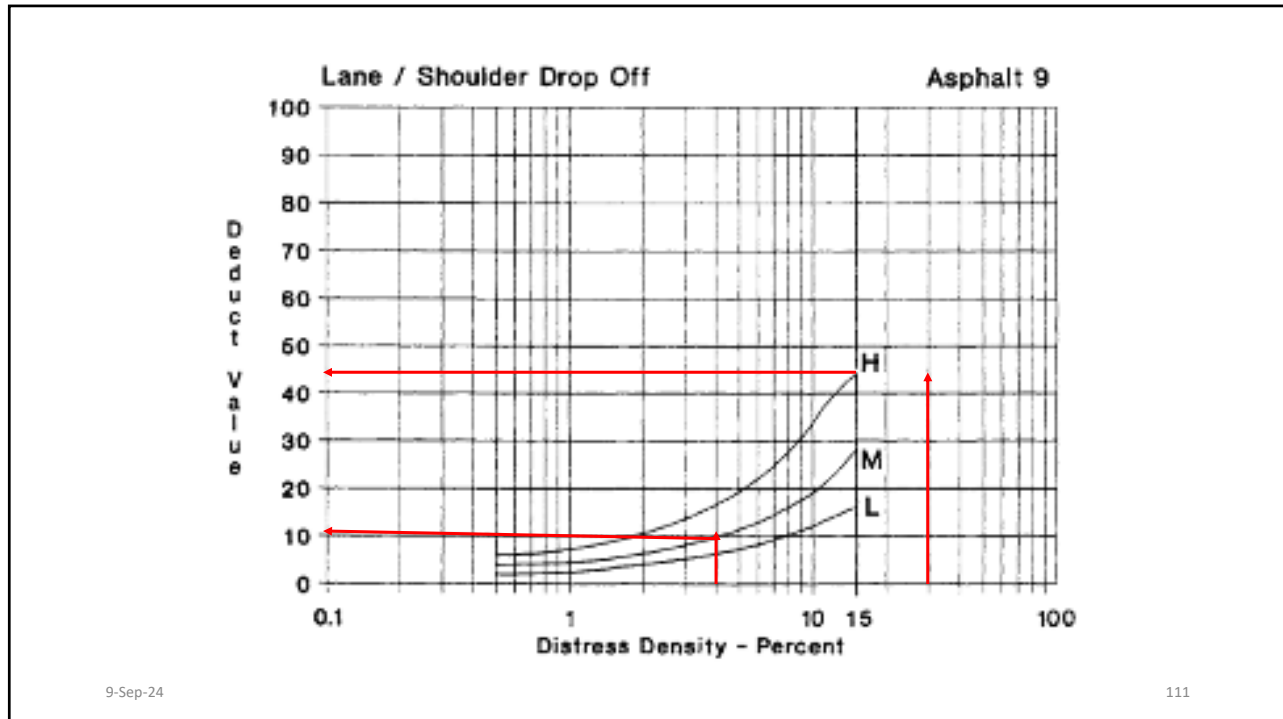44
65
54

9-Sep-24   110

110

3 – Slippery Surface
عيوب ناتجة عن سطح زلق

- Bleeding.
- Polished aggregates

A. Bleeding

- Bleeding is a film of bituminous material on the pavement surface that creates a shiny, glasslike, reflecting surface that usually becomes quite sticky.

- Bleeding is caused by excessive amounts of asphaltic cement or tars in the mix, excess application of a bituminous sealant, and/or low air void content.

- It occurs when asphalt fills the voids of the mix during hot weather and then expands onto the pavement surface. Since the bleeding process in not reversible during cold weather, asphalt or tar will accumulate on the surface.

9-Sep-24　　　　113

113

# Bleeding Sketch

كروكي لفح الامفلت
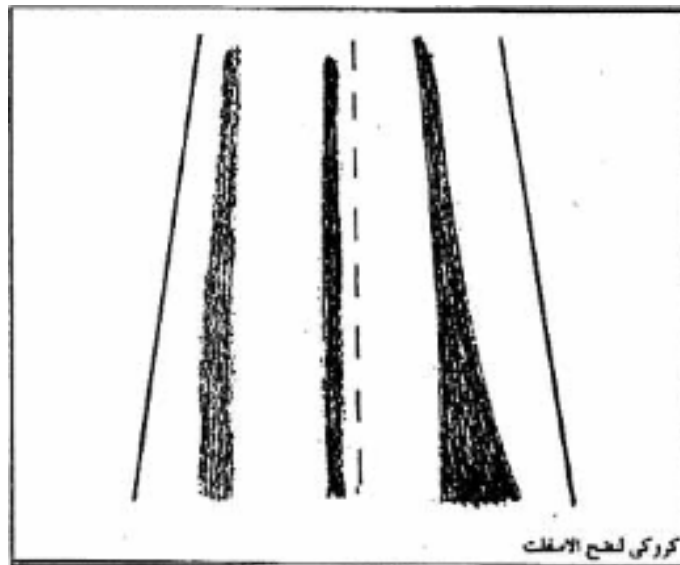
9-Sep-24　　　　114

114

Bleeding Severity Levels

L—Bleeding has only occurred to a very slight degree and is noticeable only during a **few days of the year**. Asphalt **does not stick to shoes or vehicles**.

M—Bleeding has occurred to the extent that **asphalt sticks to shoes and vehicles** during only a **few weeks of the year.**

H—Bleeding has occurred extensively and considerable asphalt sticks to shoes and vehicles during **at least several weeks of the year.**
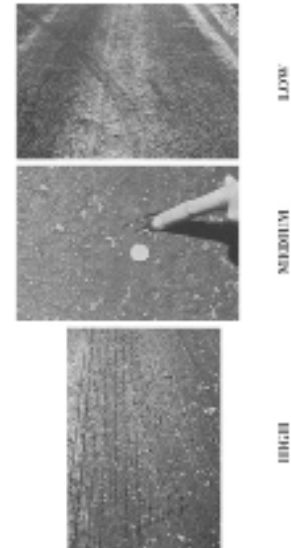
9-Sep-24

115

115

Bleeding

How to Measure

Bleeding is measured in **square feet or meter** of surface area. If bleeding is counted, polished aggregate should not be counted.

Options for Repair

L—Do nothing.
M—Apply sand/fine aggregate and roll.
H—Apply sand/fine aggregate and roll.

9-Sep-24

116

116

Example

During asphalt pavement inspection of link (100*5) M, from desert road in Egypt, 10 m² medium, 15 m² high, bleeding distress type. Determine deduct value for high distress.

10
5
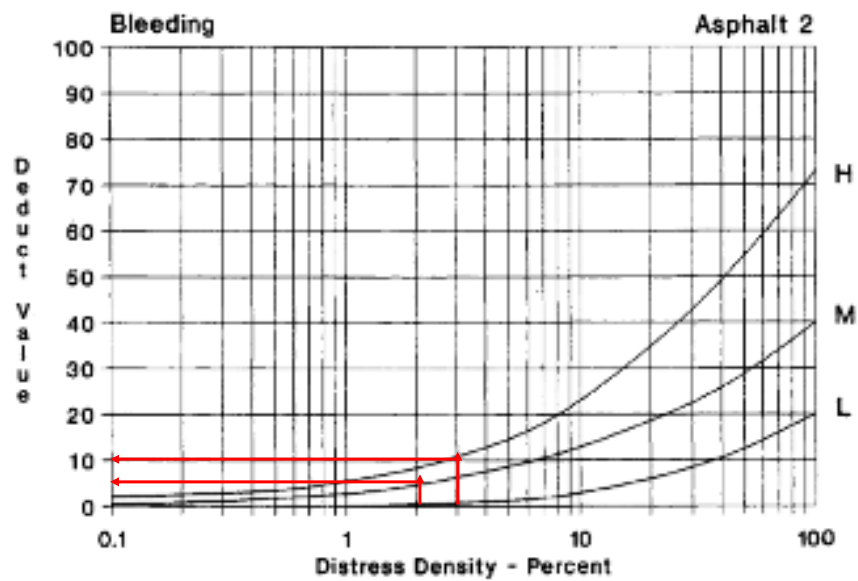15

9-Sep-24   117

117

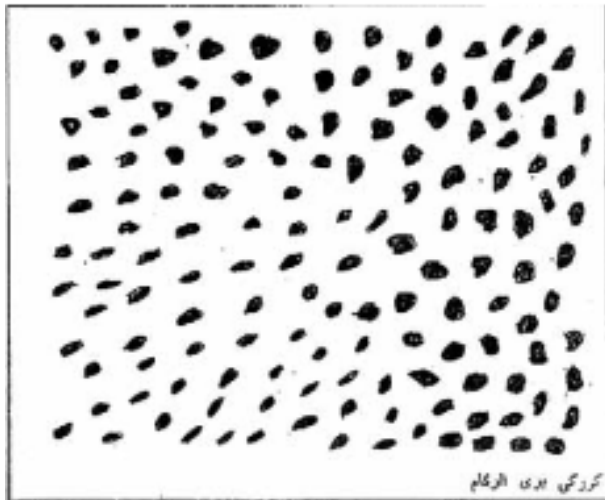9-Sep-24   118

118

B. Polished Aggregates

- This distress is caused by repeated traffic applications. When the aggregate in the surface becomes smooth to the touch, adhesion with vehicle tires is considerably reduced.

- When the portion of aggregate extending above the surface is small, the pavement texture does not significantly contribute to reducing vehicle speed.

- Polished aggregate should be counted when close examination reveals that the aggregate extending above the asphalt is negligible, and the surface aggregate is smooth to the touch. Excess of natural aggregate, more than 10%.

- This type of distress is indicated when the number on a skid resistance test is low or has dropped significantly from a previous rating
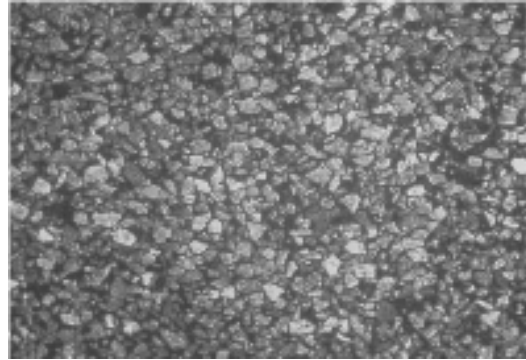
9-Sep-24

119

119

Polished Aggregates

9-Sep-24

120

120

Polished Aggregates Severity Levels

No degrees of severity are defined. However, the degree of polishing should be clearly evident in the sample unit in that the aggregate surface should be smooth to the touch.

9-Sep-24　　　　121

121

Polished Aggregates

How to Measure

Polished aggregate is measured in **square feet or meter** of surface area. If bleeding is counted, polished aggregate should not be counted.

Options for Repair

L, M, H—Do nothing; Surface treatment; Overlay; Mill and Overlay.

9-Sep-24　　　　122

122

Example

During asphalt pavement inspection of link (100*15) M, from road in Egypt, 15 m² high, 600 m² medium, polished aggregates distress type. Determine deduct value for this distress.

0

10

15

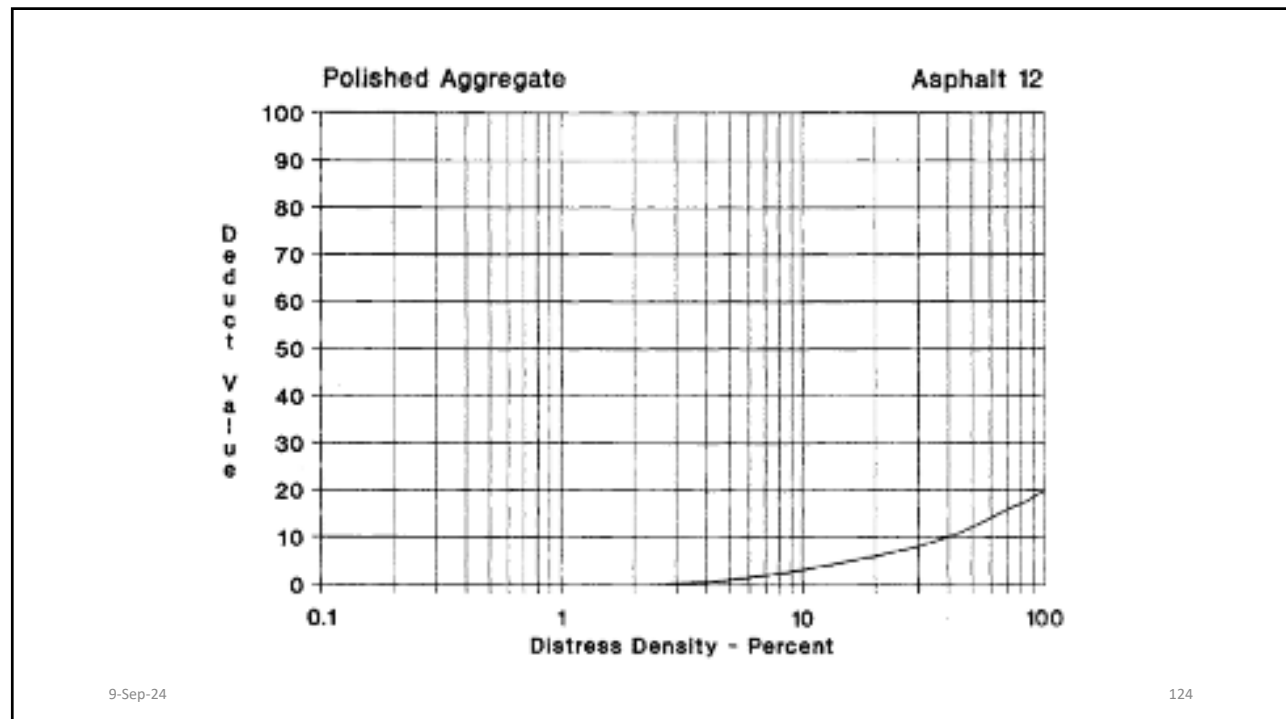20

9-Sep-24   123

123

Polished Aggregate   Asphalt 12

9-Sep-24   124

124

4 – Surface Disintegration
عيوب ناتجة عن تفكك سطح الرصف

- Weathering and Raveling.
- Potholes.
- Patching and utility cut patching.

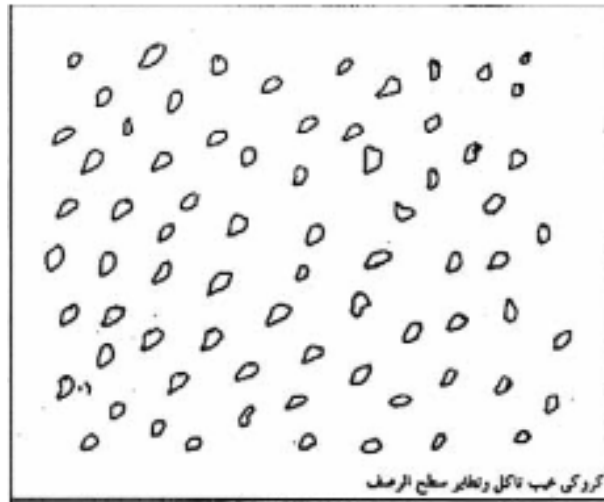9-Sep-24

125

125

A. Weathering and Raveling

- Weathering and raveling are the wearing away of the pavement surface due to a loss of asphalt or tar binder and dislodged aggregate particles.

- These distresses indicate that either the asphalt binder has hardened appreciably or that a poor quality mixture is present.

- In addition, raveling may be caused by certain types انواع معينةof traffic, for example, tracked vehicles.

- Softening of the surface and dislodging of the aggregates due to oil spillage انسكاب are also included under raveling
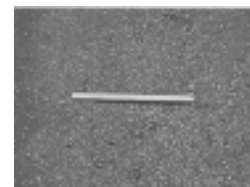
9-Sep-24

126

126

Weathering and Raveling Sketch

127

Weathering and Raveling Severity Levels

L—Aggregate or binder has started to wear away. In some areas, the surface is starting to pit.السطح بدأ بالحفر . In the case of oil spillage, the oil stain can be seen, but the surface is hard and cannot be penetrated with a coin.

M—Aggregate or binder has wear away. The surface texture is moderately rough and pitted. In the case of oil spillage, the surface is soft and can be penetrated with a coin. The pitted diameters are less than 1 cm.

H—Aggregate or binder has been worn away considerably. The surface texture is very rough and severely pitted. The pitted areas are less than 4 in. (100 mm) in diameter and less than 1/2 in. (13 mm) deep; pitted areas larger than this are counted as potholes. In the case of oil spillage, the asphalt binder has lost its binding effect and the aggregate has become loose.

128

Weathering and Raveling

How to Measure

Weathering and raveling are measured in **square feet or meter** of surface area.

Options for Repair

L—Do nothing; Surface seal; Surface treatment.

M—Surface seal; Surface treatment; Overlay.

H—Surface treatment; Overlay; Recycle; Reconstruct.

9-Sep-24

129

129

Example

During asphalt pavement inspection of link (100*15) M, from road in Egypt, 15 m^2 high (20% density), 600 m^2 medium, weathering and raveling distress type. Determine deduct value for medium distress.

18

32

50

60

9-Sep-24

130

130

Weathering and Raveling — Asphalt 19

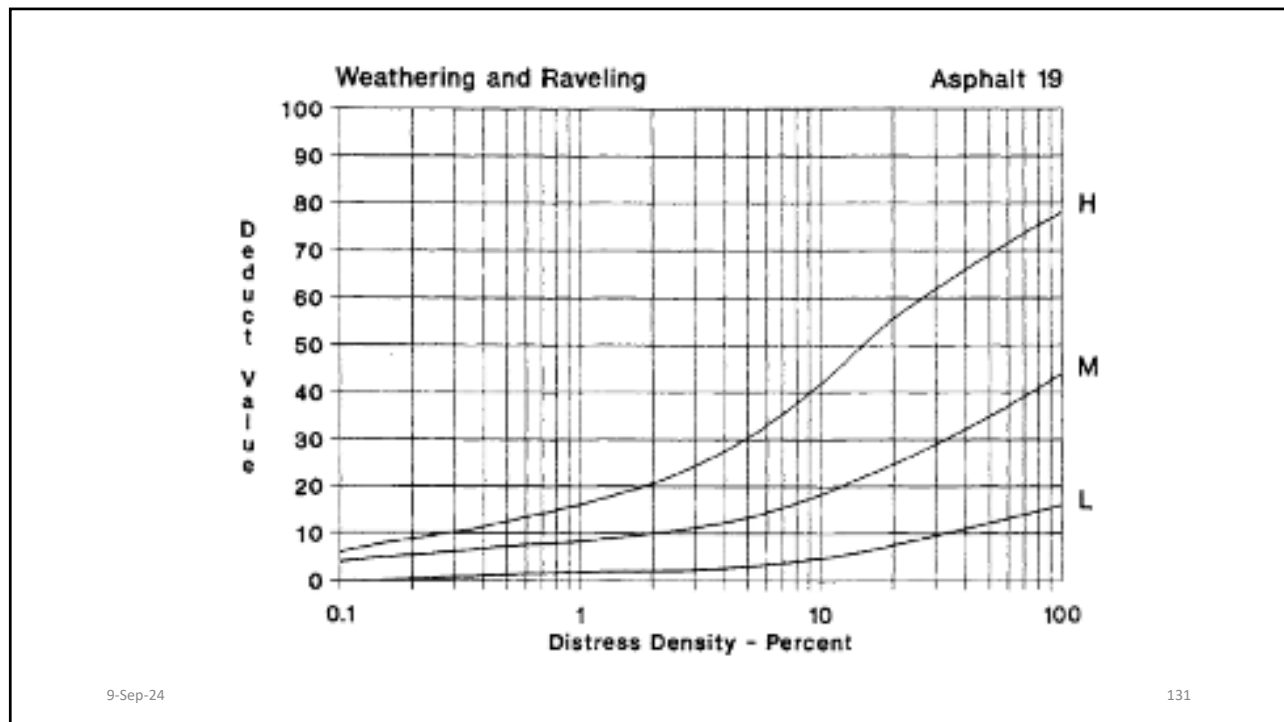9-Sep-24   131

131

B. Potholes

- Potholes are bowl-shaped depressions in the road surface. They are usually <3 ft (<1 m.) in diameter. Potholes are produced when traffic wears away small pieces of the road surface.

- They grow faster when water collects inside the hole. The road then continues to disintegrate because of loosening surface material or weak spots in the underlying soils.

- Weak of asphalt mixtures, Traffic loads, alligator, block cracking.

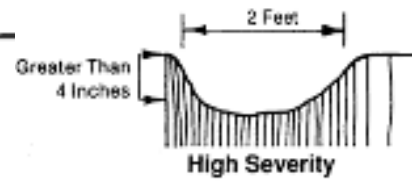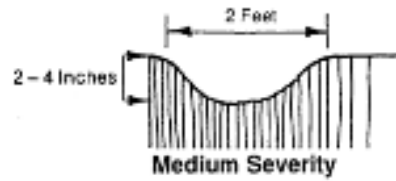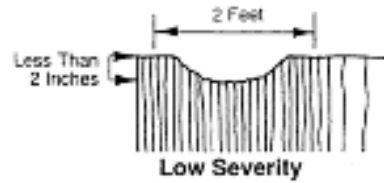9-Sep-24   132

132

Potholes Severity Levels

The levels of severity for potholes are based on both the **diameter and the depth** of the pothole according to the following table

Maximum Depth	Average Diameter			
	Less than 1 ft	1 to 2 ft	2 to 3 ft	More than 3 ft
1/2 to 2 inches	L	L	M	M
2 to 4 inches	L	M	H	H
More than 4 inches	M	H	H	H

*If the pothole is over 3 ft in diameter, the area should be determined in square feet and divided by 7 to find the equivalent number of potholes

9-Sep-24

133

133

Severity Levels

درجة الشدة :

٤٥-٧٥سم	١٥-٤٥سم	١٠-١٥ سم	قطر الحفرة
الشده			عمق الحفرة
متوسط"M"	قليل "L"	قليل "L"	٢٥ر١ - ٥ر٢ سم
عالى "H"	متوسط"M"	قليل "L"	٥ر٢ - ٥ سم
عالى "H"	متوسط"M"	متوسط"M"	أكبر من ٥ سم

9-Sep-24

134

134

Potholes

How to Measure

Number of potholes, types.

Potholes are measured by counting the number that are low-, medium- and high-severity in a sample unit and recording them separately by severity level. For example, there may be 14 potholes of medium severity and 8 potholes of low severity.

9-Sep-24

135

135

Example

During asphalt pavement inspection of link (100*10) M, from road in Egypt, 200 medium, 400 low, potholes distress type. Determine deduct value for medium distress.
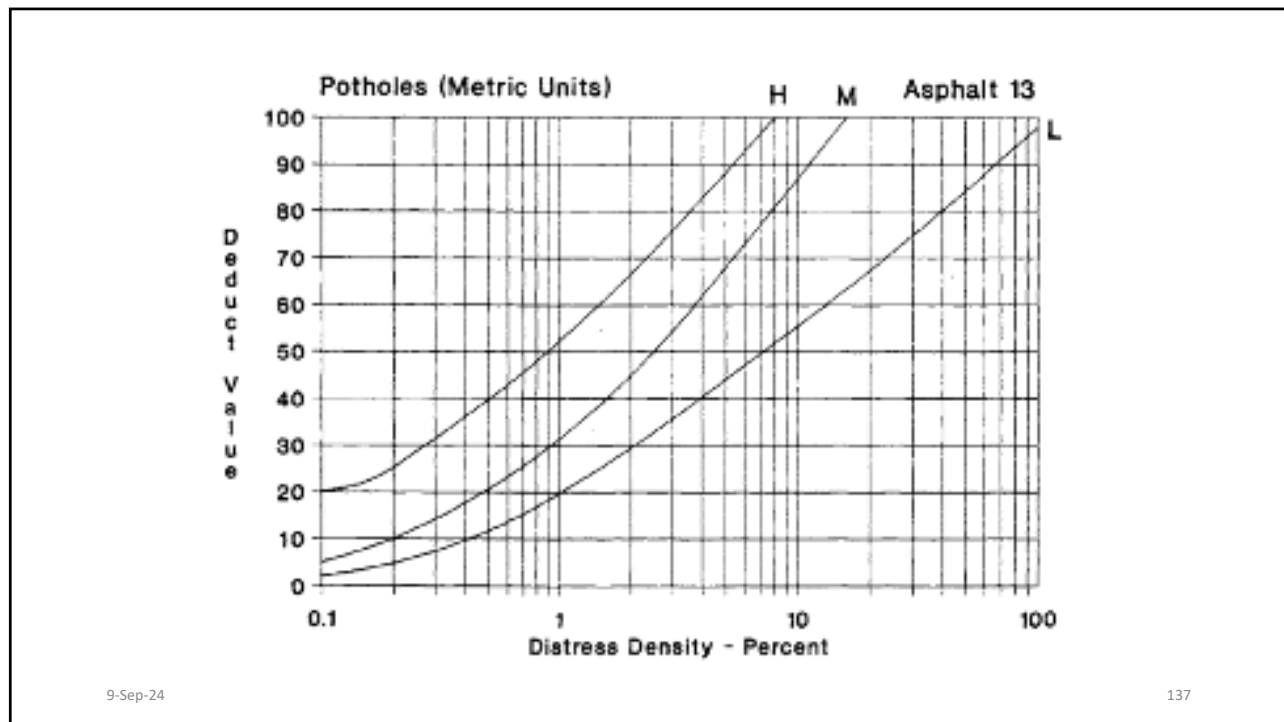
180

80

100

9-Sep-24

136

136

Potholes (Metric Units) H M Asphalt 13

9-Sep-24   137

137

C. Patching and Utility Cut Patching

• A patch is an area of pavement that has been replaced with new material to repair the existing pavement. A patch is considered a defect no matter how well it is performing (a patched area or adjacent area usually does not perform as well as an original pavement section). Generally, some roughness is associated with this distress.

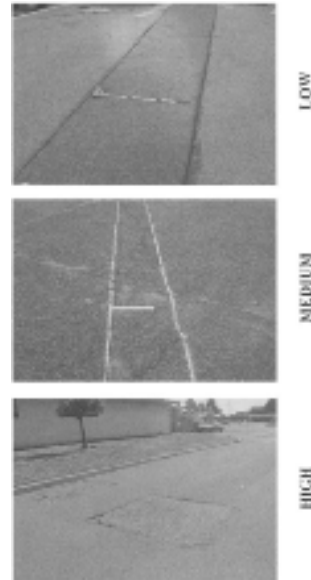9-Sep-24   138

138

Patching and Utility Cut Patching Severity Levels

L—Patch is in good condition and satisfactory. Ride quality is rated as low severity or better.

M—Patch is moderately deteriorated الترقيع هو تدهور معتدلة and/or ride quality is rated as medium severity.

H—Patch is badly deteriorated and/or ride quality is rated as high severity. Needs replacement soon

9-Sep-24   139

139

Patching and Utility Cut Patching

How to Measure
Patching is rated in **square feet or meter** of surface area. However, if a single patch has areas of differing severity, these areas should be measured and recorded separately. For example, a 25 sq ft (2.32 m2) patch may have 10 sq ft (0.9 m2) of medium severity and 15 sq ft (1.35 m2) of low severity. These areas would be recorded separately. No other distresses (e.g., shoving and cracking) are recorded within a patch; even if the patch material is shoving or cracking, the area is rated only as a patch. If a large amount of pavement has been replaced, it should not be recorded as a patch, but considered as new pavement (e.g., replacement of a complete intersection).

Options for Repair
L—Do nothing
M—Do nothing; Replace patch.
H—Replace patch.

9-Sep-24   140

140

Example

During asphalt pavement inspection of link (100*15) M, from road in Egypt, 15 m² high, 600 m² medium, Patching and Utility Cut Patching distress type. Determine deduct value for medium distress.
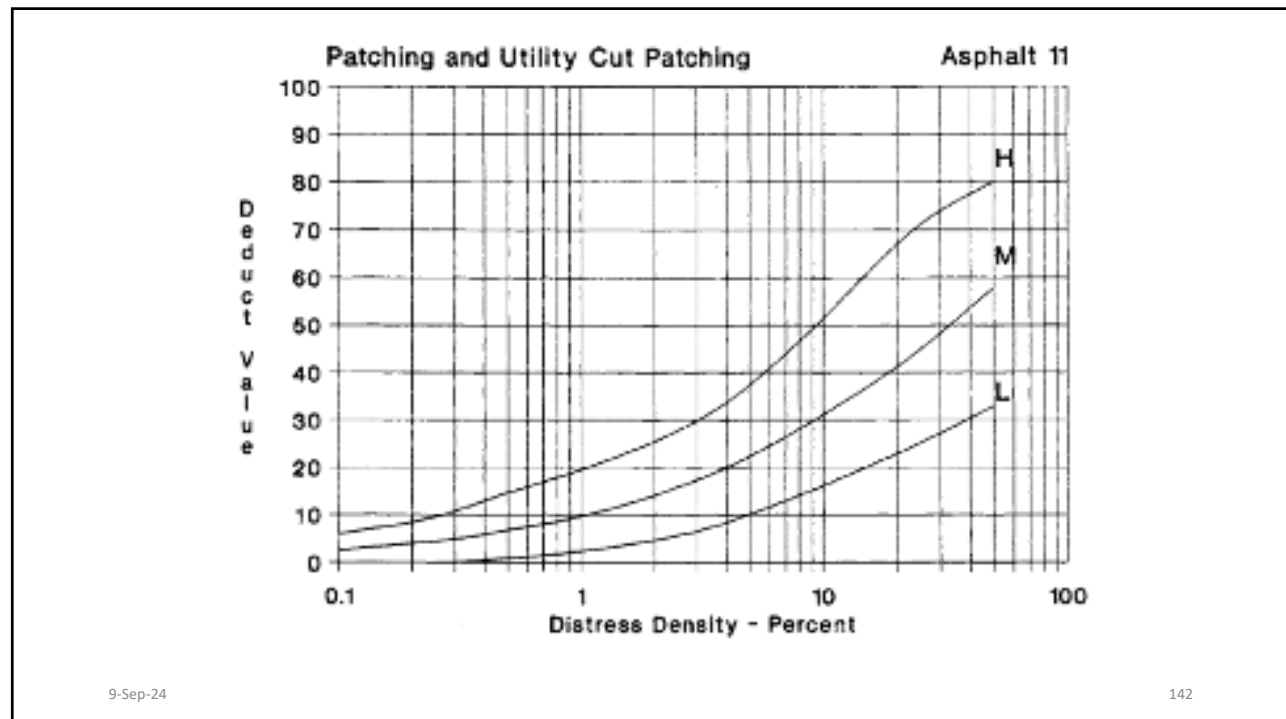
19

54

73

33

9-Sep-24

141

141

Patching and Utility Cut Patching — Asphalt 11

9-Sep-24

142

142

ASPHALT PAVEMENT INSPECTION SHEET

For use of this form, see TM 5-623; the proponent agency is USACE.

BRANCH _MOTORPOOL RD._   SECTION ___/___
DATE ___10 / 2 / 79___   SAMPLE UNIT ___/___
SURVEYED BY ___SK___   AREA OF SAMPLE _2500_

Distress Types

1. Alligator Cracking	*10. Long & Trans Cracking
2. Bleeding	11. Patching & Util Cut Patching
3. Block Cracking	12. Polished Aggregate
*4. Bumps and Sags	*13. Potholes
5. Corrugation	14. Railroad Crossing
6. Depression	15. Rutting
*7. Edge Cracking	16. Shoving
*8. Jt Reflection Cracking	17. Slippage Cracking
*9. Lane/Shldr Drop Off	18. Swell
	19. Weathering and Raveling

SKETCH:

100' 25' N DIRECTION SURVEYED

9-Sep-24   143

143

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1. Alligator Cracking. M2
2. Block Cracking. M2
3. **Edge Cracking**. M
4. **Longitudinal and Transverse Cracking**. M
5. Slippage Cracking. M2
6. Corrugations. M2
7. Depression. M2
8. Shoving. M2
9. Rutting. M2
10. Swelling or upheaval. M2
11. **Sag and Bumps**. M
12. **Lane / shoulder Drop off**. M
13. Bleeding. M2
14. Polished aggregates. M2
15. Weathering and Raveling. M2
16. **Potholes**. No.
17. Patching and utility cut patching. M2

9-Sep-24   144

144

EXISTING DISTRESS TYPE QUANTITY & SEVERITY

TYPE →	10	1	15	6		
QUANTITY & SEVERITY	10 L	1 X 6 L	2 X 25 L	6 X 4 L		
	5 L	2 X 8 M				
	15 L					
	5 M					
	10 L					
	5 M					
TOTAL SEVERITY — L	40	6	50	24		
M	10	16				
H						

9-Sep-24   145

145

PCI CALCULATION

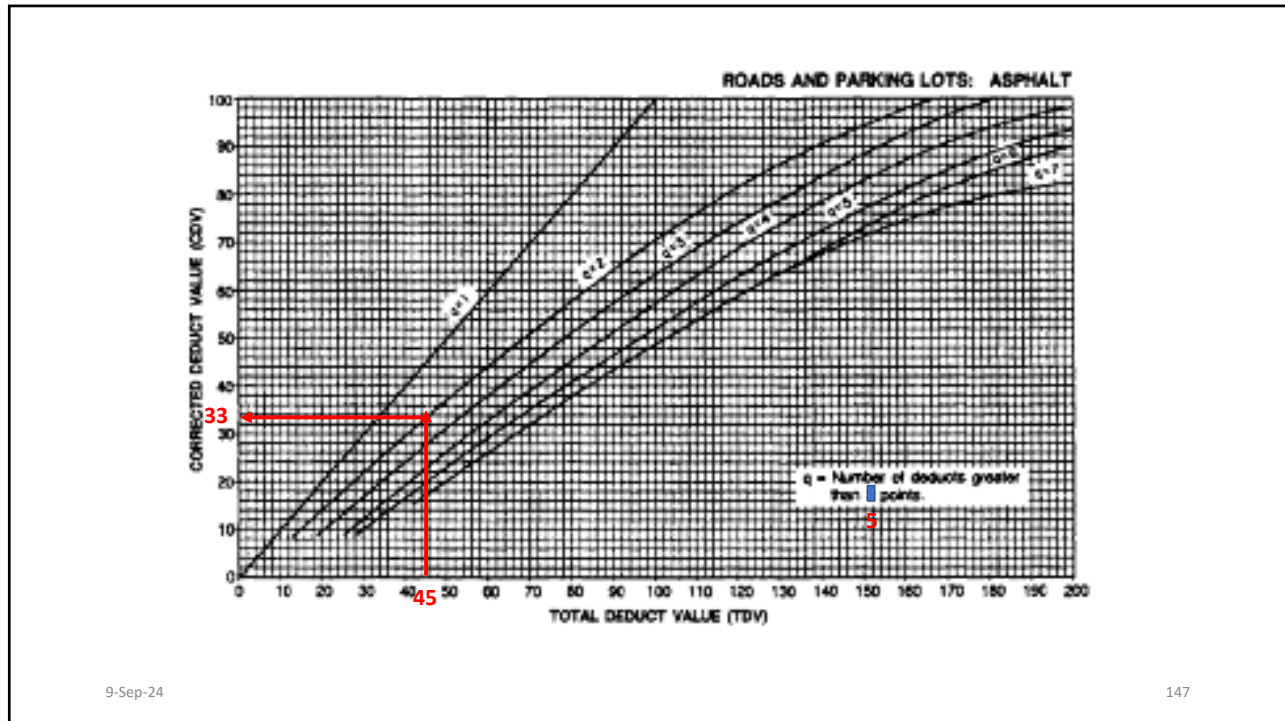| DISTRESS TYPE	DENSITY	SEVERITY	DEDUCT VALUE
1	0.24	L	4
1	0.64	M	17
6	0.96	L	4
10	1.60	L	4
10	0.4	M	3
15	2.0	L	13
q= 2 TOTAL DEDUCT VALUE			45
CORRECTED DEDUCT VALUE (CDV)			33

$PCI = 100 - CDV =$

67

RATING = **GOOD**

* All Distresses Are Measured In Square Feet Except Distresses 4,7,8,9 and 10 Which Are Measured In Linear Ft; Distress 13 Is Measured In Number of Potholes.

9-Sep-24   146

146

147

6- Rating of PCI values

PCI = 100 - CDV

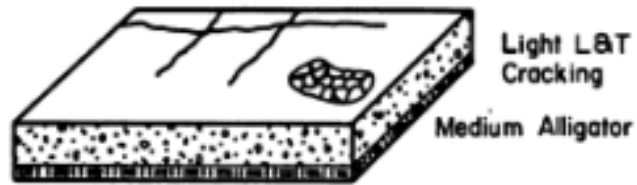| Rating	Failed	V. Poor	Poor	Fair	Good	V. Good	Excellent
PCI	0-10	11-25	26-40	41-55	56-70	71-85	86-100

PCI = 100 − 33 = 67

Rating is Good

148

Steps of calculation of Pavement Condition Index PCI

Step I. Inspect sample units: Determine distress types and severity levels and measure density.

Light L&T Cracking

Medium Alligator

9-Sep-24   149

149

Step 2. Determine deduct values.
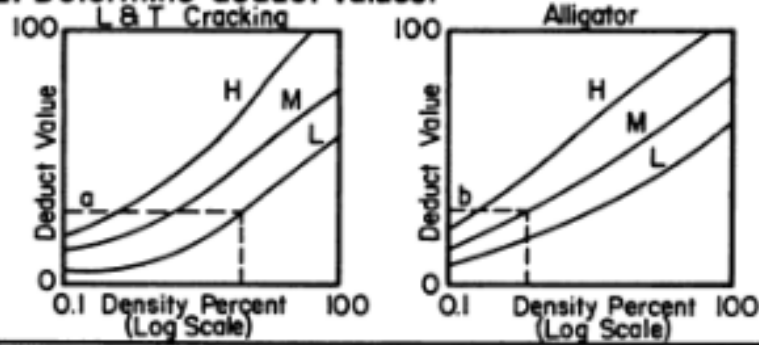

Step 3. Compute total deduct value (TDV) a+b.

9-Sep-24   150

150

Step 4. Adjust total deduct value.

q is the number of deduct greater than 5

Step 5. Compute pavement condition index (PCI) = 100 − CDV for each sample unit inspected

9-Sep-24   151

151

6- Rating of PCI values

PCI = 100 - CDV

Rating	Failed	V. Poor	Poor	Fair	Good	V. Good	Excellent
PCI	0-10	11-25	26-40	41-55	56-70	71-85	86-100

9-Sep-24   152

152